EMPLOYMENT IMPACTS OF INFORMATION SYSTEM IMPLEMENTATION IN A FEDERAL AGENCY: AN EXPLORATORY STUDY

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PREFACE

This paper was prepared for presentation at a special session on Employment Impacts of Information Technology at the Annual Meetings of the Academy of Management, Anaheim, California, August 1988. The paper presents findings from an exploratory study of employment impacts of the U.S. Forest Service's agency wide information system, a system implemented during the period 1984-1987. The study was conducted to determine the feasibility of studying employment impact patterns using very large payroll and personnel history data sets, and to quickly assess the extent to which employment impacts of the Forest Service system could be detected using a research approach adapted from techniques of organizational demography.

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I. INTRODUCTION

The effects of automation on employment have been of considerable interest to social scientists for several decades. Studies of factory automation (Buckingham, 1961; Terborgh, 1965; Rose, 1967) and back office automation (Diebold, 1964) in the 1960s viewed employment impacts as a primary focus in the study of automation in U.S. industry, while recent authors have also paid considerable attention to the interplay between information technology and labor markets (Cockroft, 1980; Hunt and Hunt, 1983).

Workers and managers have also displayed considerable interest in automation and employment issues. Jaffe and Froomkin (1968) document worker protests against automation as early as the 17th century, and managers since that time have recognized the considerable costs and potential benefits of automation, as well as its role in determining human resource needs, the design of new management techniques, and demand for specialized training programs. Finally, government policymakers have shown intense interest in the education and training implications of automation, as well as in its consequences for labor market behavior and other economic and industrial policy issues (National Resources Committee, 1937; National Commission on Technology, Automation, and Economic Progress, 1966; Leontief and Duchin, 1986).

Despite this interest and the considerable research it has generated, several central questions concerning employment impacts of automation remain unanswered. While past research has examined the interplay between automation and changing employment patterns using increasingly refined concepts, data, and methods, this research has produced diverse and often conflicting results. A consistent set of findings has yet to emerge from research on automation and employment.

In this paper we consider several explanations for apparent inconsistencies in past research and point toward unspecified or ambiguous causal mechanisms and processes as one possible source of these inconsistencies. We then propose research on employment impacts

of automation at the organization level and derive a set of research questions addressing organizational processes and mechanisms involved in the automation/employment interplay. We address these questions empirically in a sample of 756 organizational units in a large government agency and discuss the implications of our results for research at higher levels of analysis. We conclude with a discussion of outstanding questions and further research.

II. RESEARCH ISSUES IN AUTOMATION AND EMPLOYMENT

Past research has addressed a diverse set of questions pertaining to the interplay between automation and employment.[1] Analyses of evolving labor relations in the automated workplace (Cornfield, et al., 1987), trends toward "telecommuting" and other innovations in the organization of work (Olson, 1987; Feldberg and Glenn, 1987), and effects of automation on job satisfaction and quality of working life (Taylor, 1987) illustrate the range of questions examined in recent studies. Another major area of research on automation and employment has addressed effects on the content of individual jobs. Job content studies have attempted to determine whether automation and information technology *deskill* or *upgrade* jobs and workers (Spenner, 1983). Deskilling occurs through the elimination of skilled jobs and through an increasing division of work into highly routinized and compartmentalized tasks controlled by machines; deskilling thus leaves little autonomy or control in the hands of workers. Upgrading occurs through increases in skill needs, variety and autonomy, and through a reduction of mundane, routine tasks and the degree of supervision required of workers.

The major focus of automation and employment research attention, however, continues to be the study of changes in the size and characteristics of the labor force. This area of inquiry addresses such questions as whether automation causes net increases or decreases in the size of the labor force, or simply leads to shifts in the occupational distribution of workers; and whether automation leads to changes in demographic characteristics of occupations, industries, firms, and/or jobs.

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[1]The terms *automation* and *information technology* are often used interchangeably in contemporary research. Prior to the widespread diffusion of computers in the 1960s, automation referred only to production processes involving material objects. Although some authors retain this association today--reserving the term *information technology* to refer to information and data--we use both terms interchangeably. Our empirical work, however, focuses on the automation of information tasks only.

CHANGES IN THE SIZE AND COMPOSITION OF THE LABOR FORCE

Studies addressing changes in the size of the labor force have generally been conducted at highly aggregated levels of analysis, such as industry, sector, and national economy (Forester, 1981; McCurdy, 1987). This research recognizes that, at the level of a national economy, automation has several opposing effects. In firms and industries implementing automated equipment and production processes, for example, employment is expected to decrease. However, growth in the firms and industries developing and producing the automated equipment may offset decreases in automating industries.

Studies by Howell (1985) and Leontief and Duchin (1986) concluded that automation due to robots and computer technology, respectively, will eventually reduce overall employment in the U.S. by between 1 percent (Howell) and approximately 8-12 percent (Leontief and Duchin) relative to expected levels. However, their methodologies have been severely criticized and their estimates questioned (National Research Council, 1986; Cyert and Mowery, 1987). In contrast, a retrospective analysis of employment impacts of automation concluded that industry-specific employment decreases are generally offset by increased product demand, leading to net increases in employment (Young and Lawson, 1986).

Studies of the size and demographic composition of individual occupations are usually based on similar reasoning, arguing that employment in occupations undergoing automation will experience decreases, while occupations involved in the design and production of new technology will experience increases. Thus, while decreases in clerical employment primarily affect women (who hold the majority of such jobs), increased demand for professional and technical workers provides new opportunities for women's entry into these male-dominated occupations. Automation-caused changes in the size and nature of various occupations may also weaken long-held stereotypes governing the perceived appropriateness of men and women for certain jobs, leading to further change in occupational sex distributions.

Empirical studies of occupation and gender-specific effects also show mixed results. Glenn and Feldberg (1977) note that increased automation in clerical jobs has been accompanied by rapid increases in the demand for information processing and storage. Some authors have concluded that these opposing trends, while producing net increases in clerical employment during the 1970s, will produce net decreases during the 1980s (Hartmann, Kraut and Tilly, 1986). Others conclude that clerical workers will show net increases in employment during the coming decades, growing at a rate slightly above that of overall employment (Leontief and Duchin, 1986).

ORGANIZATION-LEVEL ANALYSES OF EMPLOYMENT IMPACTS OF TECHNOLOGY

The diverse and often conflicting results of automation/employment studies such as those reviewed above have several possible explanations. Differences in the locations and time periods examined and the use of diverse data sources have undoubtedly produced variation in findings. Differences in concepts and measures may also underlie many of the conflicting results. However, unspecified or ambiguous causal mechanisms and processes in previous research make comparisons of aggregate level studies and explanations difficult, such that seemingly conflicting findings may, in fact, be mutually consistent and supporting. While past studies of employment impacts have tended to measure aggregate-level effects, the processes and mechanisms by which automation produces these effects occur primarily at the level of individual organizations, organizational subunits, and work groups. Information technology and other forms of automation generally lead to changes in employment patterns by eliminating certain tasks and demands while creating others. These shifts in task needs result in changes in the composition of work groups and organizational subunits, as well as changes in the skill requirements of individual jobs. Thus, while automation may produce overall shifts in the relative size and demographic composition of various occupations at the regional or national level, these shifts may mask considerable diversity and change in individual jobs, organizational units, and organizations.

To better understand employment impacts of information technology, we examined these processes at the levels at which they operate. The primary processes comprising employment changes within organizations include (a) personnel exits, hires, transfers, or retraining, leading to changes in the number and characteristics of individuals holding various jobs; and (b) changes in the content of those jobs, or job evolution.

Changes in the number and characteristics of job incumbents, or changes in staffing patterns, can be studied through techniques of organizational demography (Pfeffer, 1983). These techniques address the demographic, tenure, and skill mix of an organizational workforce, as well as trends in these phenomena and their relationship to other organizational outcomes and processes. The degree to which demographic change occurs through each of the processes listed above depends on several factors. The degree to which the existing workforce can be retrained and adapt to new technology, for example, depends on characteristics of the workforce and the labor markets that the organization faces; characteristics of the organization and its personnel policies; and other features of workers, the organization, and its environment. Each of these factors is important to a study of organization-level demographic change.

As an initial step in examining organization-level effects of information technology on employment patterns, we obtained detailed job staffing data and information system implementation data from the U.S. Forest Service, a large federal agency. Before describing our data and methods in detail, we briefly state the research questions guiding our empirical work. These questions were derived from the literature reviewed above, as well as from related research in organization theory, human resource management, and technology implementation.

RESEARCH QUESTIONS

Our research questions address several dependent and independent variables, relating characteristics of individuals, jobs, organizations, and organizational environments to patterns of demographic change (including changes in the size and demographic composition of the

organization and its subunits, as well as changes in occupational distributions and other organizational features). We also address changes in job content as they relate to trends in labor force size and composition.

Demographic Changes in Formal Staffing Patterns

Our first set of research questions concern automation's impact on overall organizational employment levels and on the relative sizes and demographic features of jobs, occupations, and organizational subunits.

Research Question 1. Overall Employment Levels. Automation is widely believed to reduce labor requirements (holding all other factors constant--including quantitative and qualitative characteristics of output levels). However, other factors might lead to overall employment level increases, *ceterus paribus*, such as faulty or inappropriately sized systems, lack of adequate training, etc. Thus, our first research question is:

(1) What are the effects of information technology implementation on overall organizational employment levels?

Our next research questions address changes in the demographic composition of organizational units due to system implementation. In the current study we examined two demographic traits, age and gender. In subsequent research we plan to examine ethnicity as well.

Research Question 2. Employee Age. Information system implementation is accompanied by new task and skill demands, which tend to (a) increase turnover among older workers who are unfamiliar with new technology, and (b) decrease the average age of entering workers (since younger members of the labor force are more likely than older workers to have the required skills). However, if system implementation leads to employment level decreases, and these decreases are the result of attrition rather than layoffs, the decreases in hire rates would produce a gradual aging of the workforce. Thus,

(2a) Is system implementation followed by changes in mean employee age?

(2b) Do these changes differ by occupation or job, and do these differences correspond to differences in the extent to which the occupations or jobs involve work with the information system?

Research Question 3. Gender Composition. Several mechanisms operating during system implementation affect job and organization-level gender composition. First, system implementation will be accompanied by increased turnover and personnel transfers, which past research suggests are often associated with decreases in gender imbalance (Baron, Mittman and Newman, 1989). Increased personnel activity will also accelerate historical trends towards more balanced occupational gender distributions. Second, possible shortages of technological skills in the Forest Service's traditional labor pools (largely male for professional jobs and female for clerical jobs) may lead to increased hiring from nontraditional sources whose gender distributions may vary. Finally, expected increases in the size of computer-related jobs in the Forest Service will also lead to more balanced gender distributions, since computer occupations are currently undergoing changes in their sex-typing (Strober and Arnold, 1986) and are therefore more equally balanced than many other occupations. Thus,
(3a) Will system implementation be accompanied by changes in occupational gender distribution within an organization?
(3b) How will these changes vary by occupation?

Research Question 4. Occupational Composition. Our next research question addresses occupational composition. Since information technology eliminates a significant proportion of the labor involved in document revision, and also causes professional workers to become adept at keyboarding and adopt a greater portion of the text input functions formerly performed by clericals, we would expect to find increases in professional/clerical ratios. Increases in the need for programmers and other systems personnel should strengthen this effect. Thus,
(4) Will system implementation be followed by decreases in the representation of clerical workers in an organization?

Job Content Changes within Formal Staffing Patterns

We also examined changes within formal job titles, i.e., changes that cannot be measured through analyses of formal staffing data. These questions address changes in job content.

Research Question 5. Job Content Changes. While system implementation may result in the creation of new job titles and the elimination of old job titles, other existing jobs will not be affected sufficiently to warrant formal changes in job titles or descriptions, although they may undergo less significant, informal changes. Thus,

(5a) Will system implementation lead to changes in formal job descriptions, the creation or elimination or job titles, or other changes in personnel procedures?

(5b) Will formally unchanged jobs show changes in content, i.e., changes in tasks and duties?

The next section describes the research setting, data, and methods used in addressing these questions.

III. RESEARCH APPROACH

THE U.S. FOREST SERVICE

To address the research questions outlined above, we used archival data and personal and questionnaire-based surveys to study 756 organizational units of the U.S. Forest Service and its distributed information system. The U.S. Forest Service is a 30,000-employee agency of the U.S. Department of Agriculture, consisting of several hundred geographically dispersed branch locations. The National Forest System--the major operating unit of the Forest Service--is comprised of nine Regions, each headed by a Regional Office. Each Region is divided into several dozen National Forests, each containing a Supervisory Office and two or more Ranger District offices. The nine Regions include a total of 123 National Forests and over 630 Ranger Districts.

In addition to the National Forest System, the Forest Service includes several Experiment Stations, the agency's Washington, D.C. headquarters office, and various miscellaneous units, such as tree nurseries and aerial fire fighting depots. We limited our analyses to the Ranger Districts and National Forest supervisory offices in the National Forest System, thereby excluding the Washington Office, Experiment Stations, Regional Offices and miscellaneous units.

Our decision to exclude the Washington Office, Regional Offices and Experiment Stations was based on the small number of organizational units involved (i.e., one Washington Office, nine Regional Offices, and fewer than ten Experiment Stations), and the fact that these offices are extremely diverse, relative to the National Forest System. In addition, the Experiment Stations were not originally included in the information system implementation plan. The 756 National Forest Supervisory Offices and Ranger Districts in our sample represented approximately 88 percent of total Forest Service employment during the period of our study.

The U.S. Forest Service 'Forest-Level Information Processing System'

During the late 1970s and early 1980s the Forest Service began planning the implementation of a large distributed information system linking each of the branch locations in the National Forest System. The major planned uses for the system included word processing, document storage, communication, data analysis, and related tasks. Between 1984 and 1987 over 900 minicomputers and several thousand terminals were installed in offices of the Forest Service. The implementation plan was carefully planned and executed, such that approximately four to five computers were installed per week across the various Regions.

DATA AND METHODS

Our empirical analyses addressing the research questions included two primary tasks. First, we used machine-readable personnel data to examine changes in the characteristics and numbers of workers holding various job titles in different organizational units. We then related these changes to computer installation dates using standard statistical comparisons. Second, we conducted a series of telephone and personal interviews and a written survey in a sample of National Forest Supervisory Offices and Ranger Districts.

The personnel data used in our statistical analyses included personnel counts for each job title in each organizational unit, broken down by demographic category. These data were extracted from the Forest Service's Payroll History files and cover the years 1982-1987. For each organizational unit each year, these data give the number of full-time, part-time and intermittent time-base employees in each civil service (GS) job series, broken down by sex and ethnicity. The data also give the average age of the incumbents of each series in each organizational unit, as well as the average GS grade (i.e., salary level). For each year, the data files consist of approximately 10,000 job series records for the 756 organizational units in our sample.

Our telephone and personal interviews were designed to gather information from personnel officials and other key Forest Service employees concerning changes in formal personnel procedures, and formal

job descriptions and qualification requirements. We also asked questions about informal changes in tasks and duties associated with specific Forest Service jobs. The interviews were conducted in the Forest Service Washington (Headquarters) Office; in two Regional Offices; and in two National Forest Supervisory Offices and four Ranger District Offices (two per National Forest) in each of the two Regions. We conducted a total of approximately 80 personal interviews. We also administered a two-page questionnaire concerning formal and informal job changes to nearly 300 Forest Service employees in the Ranger District, National Forest Supervisory, and Regional Offices in which we conducted personal interviews. We received approximately 200 returned questionnaires, for a response rate of 67 percent. A copy of the questionnaire is included in the Appendix.

The preliminary empirical analyses reported here were limited to statistical comparisons using the personnel data, and response tabulations using the questionnaires. In future research, we plan to conduct more elaborate analyses of these data.

IV. RESULTS

ORGANIZATION-LEVEL EFFECTS

Research Question 1. Overall Employment Levels. To assess the impact of information system installation on overall employment levels, we compared changes in mean employment across several groups of organizational units. These groups were created by separating organizational units without information systems from those with systems, and further separating units with systems into groups based on the length of time their system was installed. These comparisons were used to determine if system implementation had any effect on overall employment levels, and if so, what time patterns (if any) these effects showed.

Table 1 illustrates the results of these comparisons, showing annual percentage changes in the average size (measured by total employment) of organizational units in each category. These changes are measured from the start of each calendar year. The unit categories include (a) organizational units installing an information system within six months of the measurement point (i.e., between July 1, 1984 and December 31, 1984 for the 1984-85 period ending January 1, 1985); (b) organizational units installing an information system 6-12 months prior to the measurement point (between January 1, 1984 and June 30, 1984 for 1984-85); (c) organizational units installing an information system 12-18 months prior to the measurement point; (d) organizational units installing an information system greater than 18 months prior to the measurement point; and (e) organizational units without information systems. This latter category declines each year as increasing numbers of units receive systems; note that the first two periods show figures for "All Units" only, since system installation did not begin until early 1984. To better understand the categorization scheme, note that the 193 units that received their information systems during the first half of calendar year 1984 are classified in the "Recent Installations" category during 1984-85, and in the "Long-Term Installations" category during 1985-86.

Table 1

AVERAGE ANNUAL CHANGE IN ORGANIZATIONAL UNIT EMPLOYMENT
BY CATEGORY OF ORGANIZATIONAL UNIT (*)
(Number of Units in Parentheses)

YEAR: / UNIT TYPE:	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987
No System Installed			-2.0 (426)	0.1 (266)	-2.3 (113)
New Installations (0-6 Months)			-1.2 (137)	0.2 (53)	-4.1 (70)
Recent Installations (6-12 Months)			-1.9 (193)	-4.1 (107)	2.1 (83)
Medium-Term Installations (12-18 Months)				-5.3 (137)	-4.6 (53)
Long-Term Installations (>18 Months)				-5.1 (193)	-5.4 (437)
All Organizational Units	-1.7 (756)	-4.2 (756)	-1.8 (756)	-3.8 (756)	-4.6 (756)

(*) Entries in Table give annual changes in size of workforce; changes measured in percentage.

The first trend apparent in Table 1 is the overall decrease in Forest Service employment during the period under study. In 1982 the Forest Service received a mandate to begin reducing the size of its workforce through the use of early retirement, attrition, inter-unit personnel transfers, and similar methods. Forced exits were to be avoided to the extent possible.

Our interviews with Forest Service personnel revealed that early retirements and attrition accomplished most of the reductions; layoffs were extremely rare. While most most of our informants stated that

reductions were completely independent of system implementation in their organizational units, they all believed that the information system played a significant role in allowing the agency to maintain a constant output level despite these reductions.

In light of this overall downsizing, the data in Table 1 must be examined for *relative* differences in employment level changes, rather than absolute changes in levels. Since nearly all organizational units show decreases in mean employment levels, evidence of information system effects on employment exist if the decreases experienced by units *with* systems are significantly greater than--or less than--those experienced by units *without* systems.

Comparing average employment changes for "Medium-Term Installations" and "Long-Term Installations" (for 1985-86 and 1986-87) with changes for "No System" units shows that, for periods beginning 12 months following system installation, organizational unit employment levels show significant decreases relative to changes experienced by units not receiving systems. For periods less than 12 months following installation, the pattern is less clear. In 1984-85 and 1985-86, units receiving systems showed relative increases in employment for the first six months following installation (compared to units not receiving systems), while they showed slightly greater decreases in employment during the next six months. In 1984-85 and 1985-86 employment decreases generally increased with longer periods of system installation, although this pattern did not hold for 1986-87.

Research Questions 2 and 3. Employee Age and Gender Composition. Tables 2 and 3 show results for our demographic variables, mean age and gender composition (measured by female representation). The results for age show annual increases in age, but do not show significant patterns with system implementation. The annual increases are due primarily to the overall Forest Service downsizing, which was accomplished largely through attrition. In steady state, organizational hires (most of whom are younger than the mean age of existing employees) balance retirements and other exits (most of whom are older than the mean age). During attrition, however, hire rates are significantly decreased, thus lessening the supply of young workers who balance the continuous aging of the existing workforce.

Table 2

AVERAGE ANNUAL CHANGE IN MEAN EMPLOYEE AGE
BY CATEGORY OF ORGANIZATIONAL UNIT (*)
(Number of Units in Parentheses)

YEAR: / UNIT TYPE:	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987
No System Installed			1.3 (426)	0.2 (266)	1.1 (113)
New Installations (0-6 Months)			0.6 (137)	0.3 (53)	1.0 (70)
Recent Installations (6-12 Months)			1.4 (193)	0.8 (107)	1.1 (83)
Medium-Term Installations (12-18 Months)				1.3 (137)	2.3 (53)
Long-Term Installations (>18 Months)				1.2 (193)	1.4 (437)
All Organizational Units	1.2 (756)	1.4 (756)	1.2 (756)	0.8 (756)	1.4 (756)

(*) Entries in Table give annual changes in mean age of workforce; changes measured in percentage.

Our results for gender (Table 3) also show no significant patterns relative to system implementation. During 1982-87 the Forest Service was undergoing a gradual process of gender integration, in which significant numbers of women began entering formerly all-male Forester and other professional jobs. Table 3 suggests that this process occurred relatively independently of information system implementation.

Research Question 4. Occupational Composition. Tables 4-6 show our results for the three major occupational groups in the Forest Service: Clerical, Professional, and Technical. Table 4 shows that

Table 3

AVERAGE ANNUAL CHANGE IN GENDER COMPOSITION OF WORKFORCE
BY CATEGORY OF ORGANIZATIONAL UNIT (*)
(Number of Units in Parentheses)

YEAR: / UNIT TYPE:	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987
No System Installed			2.2 (426)	-2.6 (266)	-3.2 (113)
New Installations (0-6 Months)			0.8 (137)	6.8 (53)	5.9 (70)
Recent Installations (6-12 Months)			3.6 (193)	1.6 (107)	3.3 (83)
Medium-Term Installations (12-18 Months)				0.2 (137)	-1.0 (53)
Long-Term Installations (>18 Months)				0.6 (193)	1.4 (437)
All Organizational Units	3.3 (756)	1.8 (756)	2.3 (756)	1.7 (756)	1.1 (756)

(*) Entries in Table give annual changes in women's representation in workforce; changes measured in percentage.

during the periods 1982-83 and 1983-84, the proportion of Forest Service Personnel in Clerical jobs increased slightly, followed by three years of significant decreases. While the decreases began during the initial year of system implementation, the results for "No System" units show that the decreases occurred across all units, rather than only in units with systems. Indeed, while the decreases were greater for units receiving systems during the first six months of system installation than for those without systems, units with systems actually experienced smaller decreases in their clerical workforces than units with no systems during subsequent periods.

Table 4

AVERAGE ANNUAL CHANGE IN WORKFORCE CLERICAL REPRESENTATION
BY CATEGORY OF ORGANIZATIONAL UNIT (*)
(Number of Units in Parentheses)

YEAR: / UNIT TYPE:	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987
No System Installed			-5.7 (426)	-22.4 (266)	-12.4 (113)
New Installations (0-6 Months)			-6.5 (137)	-26.7 (53)	-8.7 (70)
Recent Installations (6-12 Months)			0.2 (193)	-15.1 (107)	-7.2 (83)
Medium-Term Installations (12-18 Months)				-15.1 (137)	4.0 (53)
Long-Term Installations (>18 Months)				-8.8 (193)	-2.3 (437)
All Organizational Units	3.0 (756)	1.7 (756)	-4.2 (756)	-16.5 (756)	-4.3 (756)

(*) Entries in Table give annual changes in percentage of workforce in clerical jobs; changes measured in percentage.

Table 5 shows results for Professional jobs. This table suggests that organizational units show increases in the representation of professional jobs (relative to units without systems) during the initial six months following system implementation and at least one year following implementation, but show no consistent pattern for the 6-12 month period.

Finally, Table 6 suggests that employment in Technical jobs, which showed general declines throughout the period of study, declines more in units with information systems than in those without systems.

Table 5

AVERAGE ANNUAL CHANGE IN PROFESSIONAL WORKFORCE REPRESENTATION BY CATEGORY OF ORGANIZATIONAL UNIT (*)
(Number of Units in Parentheses)

YEAR: / UNIT TYPE:	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987
No System Installed			-0.2 (426)	-2.6 (266)	-3.3 (113)
New Installations (0-6 Months)			1.8 (137)	0.1 (53)	0.0 (70)
Recent Installations (6-12 Months)			-1.0 (193)	-2.3 (107)	0.5 (83)
Medium-Term Installations (12-18 Months)				-0.8 (137)	-1.9 (53)
Long-Term Installations (>18 Months)				1.1 (193)	1.7 (437)
All Organizational Units	1.1 (756)	2.0 (756)	0.0 (756)	-1.2 (756)	0.3 (756)

(*) Entries in Table give annual changes in percentage of workforce in professional jobs; changes measured in percentage.

JOB CONTENT EFFECTS

Research Question 5. Job Content Changes. Our interview and questionnaire surveys revealed relatively few changes in formal or informal job content. Forest Service personnel officials noted that system implementation did not result in the widespread creation of new job titles or the elimination or modification of position descriptions for existing jobs at the Forest and District levels. At the same time, our questionnaires showed only minor changes in the actual tasks and duties associated with Forest Service jobs in all classifications and

Table 6

AVERAGE ANNUAL CHANGE IN TECHNICAL WORKFORCE REPRESENTATION
BY CATEGORY OF ORGANIZATIONAL UNIT (*)
(Number of Units in Parentheses)

YEAR:	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987
UNIT TYPE:					
No System Installed			0.3 (426)	1.2 (266)	5.0 (113)
New Installations (0-6 Months)			-0.7 (137)	0.7 (53)	-1.1 (70)
Recent Installations (6-12 Months)			-0.7 (193)	0.4 (107)	0.5 (83)
Medium-Term Installations (12-18 Months)				0.7 (137)	-1.4 (53)
Long-Term Installations (>18 Months)				-1.3 (193)	-1.2 (437)
All Organizational Units	-2.0 (756)	-0.3 (756)	-0.1 (756)	0.4 (756)	-0.2 (756)

(*) Entries in Table give annual changes in percentage of workforce in technical jobs; changes measured in percentage.

functional units sampled. While several incumbents of system-related jobs reported recent transfers into those jobs--with associated changes in their tasks and responsibilities--individuals holding system-related jobs prior to installation of the new computer reported very few changes.[1]

[1]A more detailed discussion of the findings from the questionnaires will be contained in a forthcoming report entitled *From Implementation to Internalization: A Follow-On Study of the Forest Service's Agency-Wide Information System.*

V. DISCUSSION AND CONCLUSIONS

Our findings regarding overall employment levels suggest that, while information technology implementation is associated with net decreases in employment levels in Forest Service offices, these decreases are not immediate. This result is consistent with the literature on information technology implementation (see the review by Bikson, Gutek and Mankin, 1981), which discusses temporary and long-term barriers such as training needs, initial "shake-down" or "break-in" periods, and the practice of running the obsolete system in parallel with the new system during this break-in period.

The demographic results show relatively few information system impacts. Trends in employee age are driven primarily by overall agency downsizing; our ability to discern effects of automation alone await further efforts to control for this downsizing. Our results for gender are further complicated by the Forest Service-wide trends towards gender equality, and by our mixed results for clerical workforce representation, since clerical workers are overwhelmingly female.

The occupational composition results show several interesting patterns, including some which were unexpected. The counter-intuitive results for technical jobs are caused primarily by the fact that the technical job category in the federal Civil Service includes sub-professional jobs such as Forestry Technicians and Engineering Technicians, in addition to system-related titles. Since sub-professional workers generally have higher turnover rates than professional workers, the Forest Service downsizing was partially accomplished through attrition of these technical workers. These attrition rates may have increased following system implementation, because of increased demands for clerical workers (see below), the other major category that experienced decreases during downsizing.

The results for clerical jobs, however, are counter to our expectations and have no simple explanation. Many Forest Service units may have intended to accomplish a large part of their mandated

reductions through the elimination of clerical jobs, and saw the new information system as a way of achieving these reductions with minimal impact on output. Thus, the finding that units with systems show smaller decreases in clerical workforces than those without systems is somewhat unexpected. While units with systems show greater decreases during the initial six-month period, these are not sufficient to offset the smaller decreases that occur during subsequent periods. It appears as if the clerical workforce was cut back in anticipation of system-related reductions in workloads, but as reductions did not occur, further cutbacks were slowed. Indeed, 53 units with systems in place between 12 and 18 months by January 1987 actually showed increases in the proportion of their workforces in clerical jobs.

This finding suggests that automation-related changes in employment patterns show only an indirect link to changes in workloads; this link is mediated by managerial perceptions and expectations regarding workload changes. This finding has significant implications for aggregate-level studies of employment impacts, which mask the organizational processes and mechanisms through which employment changes occur.

Finally, our findings related to job content were significant for the lack of change they revealed. While the Forest Service used a variety of types of computer equipment prior to the installation of the new system, the old equipment was highly specialized and limited to only certain groups of professional and technical workers. The new system created numerous novel demands and needs, yet formal adaptation to the system has been minimal. This is attributable in part to the Forest Service's use of the "collateral duty" rule, which permits changes in up to 50 percent of the duties and responsibilities of a job before the job must be evaluated for possible reclassification.

The results described above, which we view as preliminary and suggestive rather than conclusive, highlight several avenues for further research. First, we intend to apply more sophisticated statistical techniques in order to better understand the contributions of agency-wide downsizing and information system implementation on the Forest Service workforce. Second, we intend to utilize employee-level

personnel transaction data to better understand the mechanisms and processes behind the job- and subunit-level results described above. Finally, we hope to use techniques of job analysis to better understand changes in individual jobs associated with system implementation.

APPENDIX

Job Content Questionnaire

FROM IMPLEMENTATION TO INTERNALIZATION: JOB IMPACTS OF COMPUTERS IN THE U.S. FOREST SERVICE

The RAND Corporation
Santa Monica, California
213-393-0411

At the request of the Forest Service, The RAND Corporation is conducting a study of computerization in the Agency. Your assistance in completing this form will enable us to better understand the ways in which the use of computers has changed the nature and content of jobs in the Forest Service. Specifically, we want to learn about what has happened between the time when computers were used mainly by small numbers of employees for specialized purposes (e.g., road design, timber stand analysis) and now, when almost everyone makes use of a computer for quite general purposes (e.g., electronic mail) as well as specific applications.

The information you provide on the form is anonymous and will be used with forms from other Districts and Forests to create summaries. No information from individual forms will be reported, and the information will not be used in any way that would allow the identification of individual jobs or respondents.

Your participation in this survey is completely voluntary, but we hope you will take the time to complete the form. If you should have any questions about the survey or the information we would like to obtain, please contact Dr. Cathleen Stasz or Dr. Brian Mittman at the phone number given above (collect). When you have completed the survey form, please detach this cover sheet and enclose the form in the attached envelope. Please return the form by the end of the day if possible.

Thank you very much for your assistance with our research.

FROM IMPLEMENTATION TO INTERNALIZATION: JOB IMPACTS OF COMPUTERS IN THE U.S. FOREST SERVICE

CURRENT JOB INFORMATION

1) Forest: _____ Ranger District: _____
(or "Supervisory Office")

2) GS Occupational Series: _____ Job Title: _____

3) Major Job Responsibilities:

_____

_____

_____

_____

BACKGROUND INFORMATION

4) Number of years in current position: _____

5) Number of years in this office: _____

6) Number of years in the Forest Service: _____

7) Do you use a computer at work? (Check all that apply)

No____ DG____ Other minicomputer____ PC____ Fort Collins____ Other____

8) If you use a computer at work, were you employed by the Forest Service before the widespread introduction of computers for everyone's use in the Agency?

Yes____ No____

If you answered Yes to Question 8, please continue with the form. If you were doing the same type of work before the widespread introduction of computers throughout the Forest Service, answer the remaining questions with direct reference to your own experience. If you were in a different position but have some ideas about how widespread computerization affected the job you now do, please answer *from* that perspective.

9) I was in the same type of job before the widespread computerization of the Forest Service:

Yes____ No____

10) Are there any tasks you (or someone in this same position) perform now but didn't perform before the widespread use of computers? Please list.

11) Are there any tasks you (or someone in this same position) used to perform but no longer perform since the widespread use of computers? Please list.

12) Did this job change in any other way as a result of computers (e.g., any difference in where work is done such as field vs. office, or when it is done, or with whom)? Please describe.

13) Have any of the following changed for this position as a direct result of the widespread introduction of computers? If not, will they? Should they?

	Has changed	Will change	Should change
Job title			
Job description			
GS level			
GS classification			
Pay			
Career path			

14) Is there anything else we should know regarding your job and its relationship to computerization? Please continue on the reverse if necessary.

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